CLAIMS

We claim:

1. A suspension system for a vehicle having a wheel contacting a surface under the vehicle and a suspension link suspending the wheel from the vehicle and allowing relative movement of the wheel and the vehicle, said suspension system comprising:

a compressible fluid;

a suspension strut adapted to couple the suspension link and the vehicle;

a hydraulic cavity at least partially defined by said suspension strut and adapted to contain a portion of said compressible fluid and to cooperate with said compressible fluid to supply a suspending spring force that biases the wheel toward the surface;

a reservoir adapted to contain a portion of said compressible fluid; and

a volume modulator coupled to said hydraulic cavity and said reservoir and adapted to selectively push said compressible fluid into said hydraulic cavity and vent said compressible fluid from said hydraulic cavity, thereby actively modulating said suspending spring force, wherein said volume modulator defines a modulator cavity and includes a modulator piston adapted to cycle through a compression stroke and an expansion stroke within said modulator cavity, and includes a valve system adapted to selectively restrict the passage of said compressible fluid between said hydraulic cavity and said modulator cavity or restrict the passage of said compressible fluid between said reservoir and said modulator cavity.

2. The suspension system of Claim 1 wherein said suspension strut includes a displacement rod adapted to move into said hydraulic cavity and to compress said compressible fluid upon the relative movement of the wheel and the vehicle.

3. The suspension system of Claim 2 wherein said displacement rod includes a cavity piston adapted to supply a damping force.

4. The suspension system of Claim 1 wherein said hydraulic cavity is defined by said suspension strut and a hydraulic line adapted to communicate said compressible fluid between said suspension strut and said volume modulator.

5. The suspension system of Claim 1 wherein said compressible fluid includes a silicone fluid.

6. The suspension system of Claim 1 wherein said compressible fluid has a larger compressibility above 2,000 psi than hydraulic oil.

7. The suspension system of Claim 1 wherein said compressible fluid is adapted to compress about 1.5% volume at 2,000 psi, about 3% volume at 5,000 psi, and about 6% volume at 10,000 psi.

8. The suspension system of Claim 1 wherein said valve system includes a rotary valve coupled between said modulator cavity, said hydraulic cavity, and said reservoir.

9. The suspension system of Claim 8 wherein said rotary valve is adapted to selectively rotate to a first position thereby restricting the passage of said compressible fluid between said hydraulic cavity and said modulator cavity and allowing the passage of said compressible fluid between said reservoir and said modulator cavity.

10. The suspension system of Claim 9 wherein said rotary valve is further adapted to selectively rotate to a second position thereby restricting the passage of said compressible fluid between said reservoir and said modulator cavity and allowing the passage of said compressible fluid between said hydraulic cavity and said modulator cavity

11. The suspension system of Claim 10 further comprising an electric control unit coupled to said rotary valve and adapted to rotate said valve into the first position during said expansion stroke and to rotate said rotary valve into the second position during said compression stroke, thereby pushing said compressible fluid into said hydraulic cavity.

12. The suspension system of Claim 11 wherein said electric control unit is further adapted to rotate said valve into the second position during said expansion stroke and to rotate said rotary valve into the first position during said compression stroke, thereby venting said compressible fluid from said hydraulic cavity.

13. The suspension system of Claim 1 further comprising a hydraulic cavity valve coupled along said hydraulic cavity between said volume modulator and said suspension strut and adapted to selectively restrict the passage of said compressible fluid through said hydraulic cavity and to selectively allow the passage of said compressible fluid through said hydraulic cavity.

14. A volume modulator adapted to be coupled to a hydraulic cavity and a reservoir and to selectively push a fluid into the hydraulic cavity and vent the compressible fluid from the hydraulic cavity, said volume modulator comprising:

a modulator cavity;

a modulator piston adapted to cycle through a compression stroke and an expansion stroke within said modulator cavity; and

a rotary valve coupled between said modulator cavity, the hydraulic cavity, and the reservoir and adapted to selectively restrict the passage of the fluid between the hydraulic cavity and said modulator cavity or restrict the passage of the compressible fluid between the reservoir and said modulator cavity.

15. The suspension system of Claim 14 wherein said rotary valve is adapted to selectively rotate to a first position thereby restricting the passage of the fluid

between the hydraulic cavity and said modulator cavity and allowing the passage of the fluid between the reservoir and said modulator cavity.

16. The suspension system of Claim 15 wherein said rotary valve is further adapted to selectively rotate to a second position thereby restricting the passage of the fluid between the reservoir and said modulator cavity and allowing the passage of said compressible fluid between the hydraulic cavity and said modulator cavity

17. The suspension system of Claim 16 further comprising an electric control unit coupled to said rotary valve and adapted to rotate said valve into the first position during said expansion stroke and to rotate said rotary valve into the second position during said compression stroke, thereby pushing the fluid into the hydraulic cavity.

18. The suspension system of Claim 17 wherein said electric control unit is further adapted to rotate said valve into the second position during said expansion stroke and to rotate said rotary valve into the first position during said compression stroke, thereby venting the fluid from the hydraulic cavity.

19. The suspension system of Claim 14 further comprising a hydraulic cavity valve coupled along the hydraulic cavity adjacent said volume modulator and adapted to selectively restrict the passage of the fluid through the hydraulic cavity and to selectively allow the passage of the fluid through the hydraulic cavity.